Thursday, May 18, 2017 8:44 AM

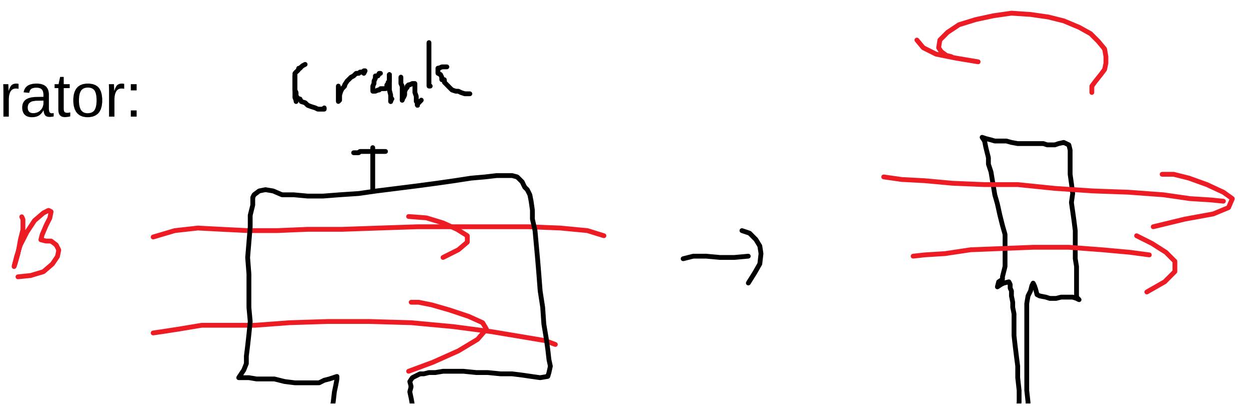
From homework:
Q13 requires resistivity,
$R=\rho L/A$ (not part of the course, sorry)

$emf=-N\Delta\Phi/\Delta t = 1x(3.14159x0.09x0.09)$
$x(0.85)/t=0.02163$ V/t
I=V/R
q=It =0.02163V/~~t~~ ~~x~~t /R

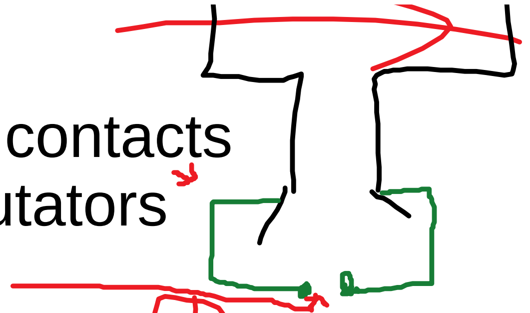
Generators, Motors and Transformers

A generator is a coil of wire in a magnetic field. If you move the coil or change the magnetic field a current is induced.
- all your power results from this:
  hydro - moving water spins the generator
  nuclear/fossil fuels/geothermal - heat water, the steam spins the turbine - generator
  wind - the wind turns the turbine
  exceptions: solar - photoelectric cells

Generator:



sliding contacts
commutators



output

$\Phi = 0$

$\Phi = BA$

$Emf = -N\frac{\Delta\Phi}{\Delta t}$ $\quad I = \frac{Emf}{R}$

Keeners - derivation

$$\Phi = BA\cos\theta$$

if it spins at a frequency, f

$$\Phi = BA\cos(2\pi f t)$$

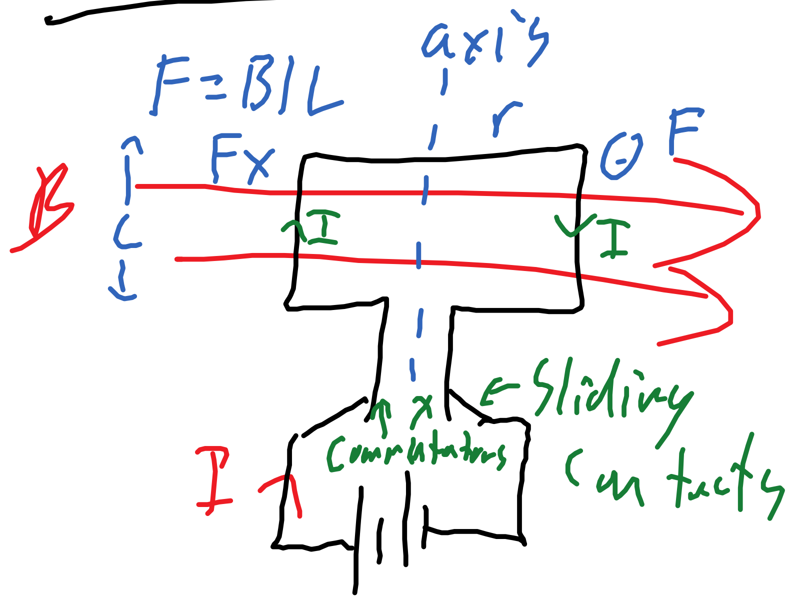
$$\frac{d\Phi}{dt} = -2\pi f BA\sin(2\pi f t)$$

$$\max Emf = \boxed{2\pi f NBA}$$

Voltage of generator

is proportional to f, N, B, A

Electric Motor



2 wires/loop

$\tau = 2 F r \sin\theta$

$F = NBIL$

$\tau = N B I 2 r L \sin\theta$

$\tau = N B A I \sin\theta$

sliding contacts between the power supply and the commutators - contact points.

Look at our demo motor:
if I hold the armature (spinning thing) the current is 5.5A and the voltage was 3.0V
If I let it run, the current drops to 1.0A and the voltage is 4.3V.

What's the deal? The resistance of the wires are the same, why doesn't it match up with Ohm's Law?

R=V/I = 3/5.5=0.5455 ohms hold armature
if it spins, R=4.3/1=4.3 ohms ?????

This is a result of the electric motor acting as a generator as it spins. The spinning coil induces an emf opposing the applied emf, we call this the back emf.

What is the back emf of our demo motor?

back emf, V_{back} = emf - Ir

r is the resistance of the armature, find it by r=V/I with no back emf - not spinning.

r= 3/5.5=0.5455 ohms is the resistance of the armature.

back emf = 4.3V - 1.0A(0.5455 ohms)
back emf = 4.3-0.5455**=3.7545 V**
back emf = 3.8V

How could you reduce back emf?

if you reduce the rotation rate, you reduce the back emf proportionally - gear ratios.

The second motor has the same armature resistance but V=4.0V and I = 4.0 A

so the back emf = 4.0V - 4.0A(0.5455ohms)

4-(4x0.5455**)=1.818 V**

p567

Q15, 17, 19, 21 prep lab p109 - data table

equations:

peak emf = $2\pi fNBA$

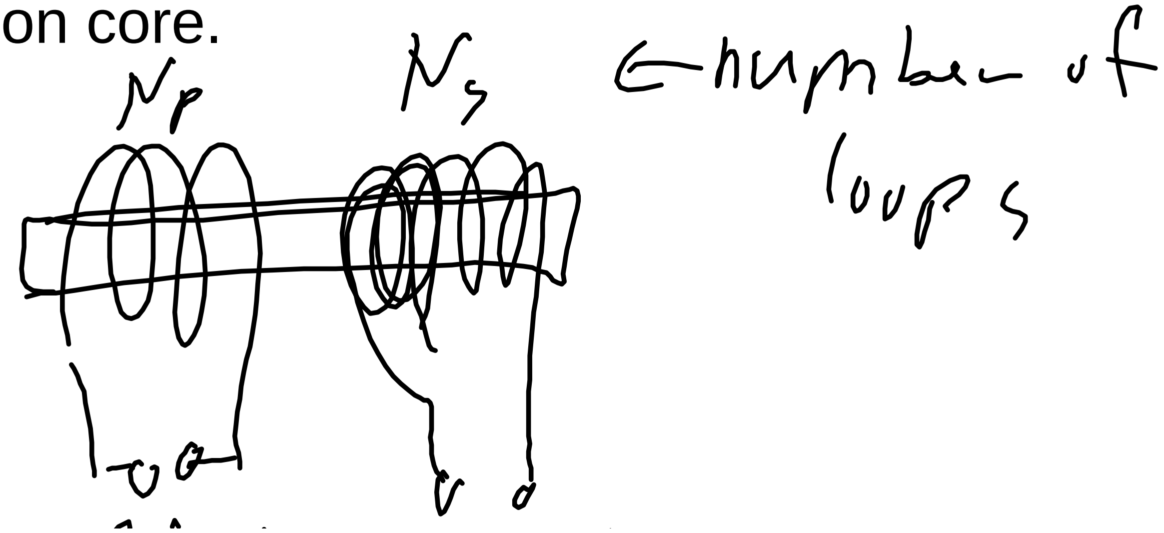
V_{back} = emf-Ir

eg. An aluminum airplane with wingspan of 10.0 m is moving at 50.0 m/s going North near the North pole. The magnetic field of the Earth is about 1.5×10^{-4}T.

a) what is the sign of the charge of the Eastern wingtip?
b) what is the emf between the wingtips?
c) Why is this a problem? How could you fix it?

Transformers:

Two sets of coils of wire, the first is called the primary, the second the secondary, with a common core.



primary secondary

An alternating current is required for a current to be induced in the secondary.

The number of loops determine the voltage and current induced, but it follows conservation of energy, not ohm's law.

Pin = Pout

$V_p I_p = V_s I_s$

$V_p/V_s = I_s/I_p = N_p/N_s$

the beauty of the transformer, is you can step up the voltage ($V_s > V_p$) and lower the current, reducing power loss in transmission.

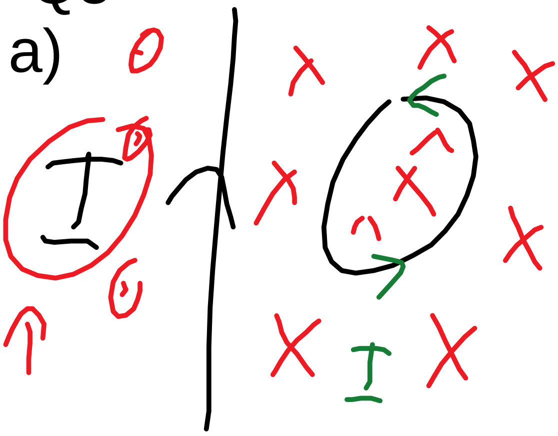
eg. a generator provides 240V and 5.0×10^6W of power through 2.0 ohm transmission cables. How much power is lost if

a) no transformer?
b) a transformer with 10 loops in the primary and 100 loops in the secondary is used before the cables?

c) what if the secondary has 1000 loops?

Q5

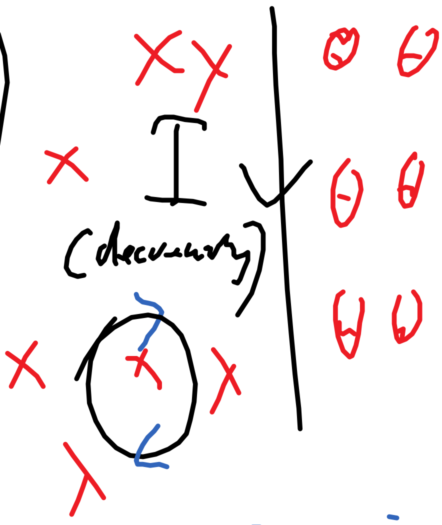
a)



$$Emf = -N\frac{\Delta\Phi}{\Delta t}$$

create B out of page opposing $\Delta\Phi$

b)



Creates B - into page opposing the loss of B

1. An aluminum airplane moving at 50.0 m/s through the Earth's magnetic field of 1.5 x 10^{-4}T, with a wingspan of 10.0m. What is the potential difference across the wings? If it is flying north, near the North Pole, which wing is positive, East or West?
emf = Blv = 0.00015Tx(10.0m)x(50.0m/s)
0.00015x10x50=0.075 V